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MONITORING AND CONTROL OF CONDITION OF TRANSFORMER BY ONLINE BASED MICROCONTROLLER

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ABSTRACT

The insulated state is one of the most important problems of transformer because incipient faults are the major cause for the deterioration of insulation in the transformers. Low-cost, online incipient fault detection for Transformers is essential due to high cost involved in conventional methods. Electrical, Thermal, or Chemical effects can be observed during fault condition. One of the simplest and most effective ways to monitor a transformer condition is through temperature sensors. In this paper digital based monitoring of transformer state is designed using the control system involving PIC microcontroller PIC 16F876A. The controller has an inbuilt ADC with 5 input channels to monitor 5 parameters. Among the 5 channels, only two channels are used to monitor temperature, over load condition and control strategy is developed such that transformer will be disconnected from the supply if the temperature and load conditions are greater than preset values. Provision is given for the model so that GPRS system may be interfaced to facilitate for transmitting the measured parameters to remote monitoring units.

KEYWORDS: Transformer, Microcontroller, Sensors, Fault

INTRODUCTION

Transformer is a critical equipment of power system. The reliable operation of transformer helps in proper working of the power system. One of the most important parts of the transformer is the insulating system which will deteriorate due to over loading, inter turn faults, aging, partial discharges etc and thus contributes for failure of the transformer. There are several Conventional methods such as dissolved gas analysis and partial discharge analysis have been successfully applied to transformer fault diagnosis in past but involves high-cost and are offline. In offline methods manually personnel checks periodically the condition of the transformer in terms of significant parameters such as temperature, gas, currents, voltages etc. But these methods are time consuming and cannot prevent sudden failure of the transformer. Therefore low-cost, online incipient fault detection for Transformer is very much essential. Online condition monitoring of transformers can give early warning of electrical failure and could prevent catastrophic losses. One of the simplest and most effective ways to monitor a transformer externally is through temperature sensors[1].

Abnormal temperature readings almost always indicate some type of failure in a transformer. Thus online monitoring extend over all life time of the transformer, reduce the risk of an unplanned catastrophic failures, facilitate to monitor the transformer for detecting premature possible internal failures etc., In order to achieve the online monitoring of the transformer, microcontroller based designs can be preferred due to its versatile features while processing the data

corresponding to the parameters. During the past years a number of researches contribute with the help of microprocessors and controllers for incessant monitoring of system parameters. During odd proceedings for some reasons the transformer is prone for increase in temperature of the insulation due to the over load and short circuit in their winding.

Also the oil temperature is increased due to the increase in the level of current flowing through their internal windings. This results in an unexpected rise in voltage, current or temperature in the distribution transformer. Therefore, automation of the monitoring of transformer is required

Real-time monitoring of power quality necessitates great abilities of data-handling and data-processing. These requirements limit the possibility of monitoring, in spite of the fact that microprocessor-based monitoring systems have observed vital development in their storage and computational power[2]. Development of compact algorithms will benefit power quality because they will allow monitoring of more points simultaneously for large systems, and, they will help in building powerful embeddable monitoring architectures within small power devices

SCHEMATIC DIAGRAM OF THE SYSTEM

In general transformer winding contains capacitance between the adjacent turns with in a disc or layer, capacitance between the adjacent discs or layers, capacitance to ground and to other windings. Similarly there exists self and mutual inductances as pertaining to the individual turns, the discs/sections, one part of the winding to another or one whole winding to another. Although both the capacitance and inductance are of distributed nature for practical computation purposes these have to be lumped in varying degrees according to the desired accuracy. During disturbances the core of the transformer experiences stress and the effect of it can be observed in the form of temperature.

Basing on the effects that can occur during the disturbance, microcontroller based architecture is realized based on the model shown in figure 2. In transformer the design objective will be to remove the heat as early as possible because the temperature rise in the core will decrease the dielectric strength of the dielectric material and leads to inter turn fault and then to short circuit .In the diagram shown in figure 2.

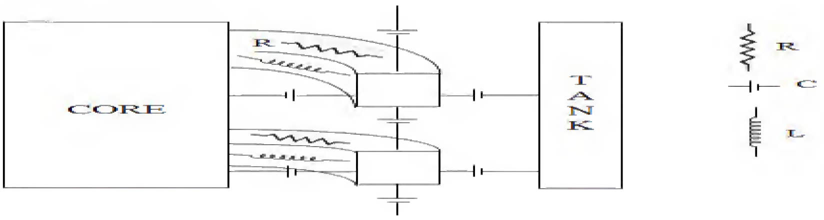

Figure 1: Transformer Winding Model

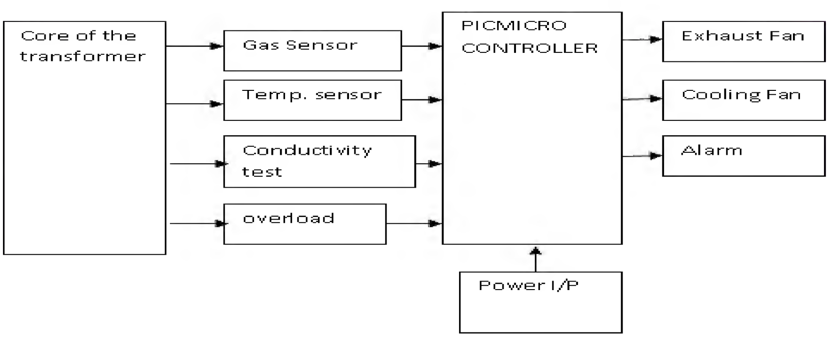

Figure 2: Microcontroller Based Transformer Winding Model

The rise in the temperature will be sensed by the processor and disconnects the transformer from the supply by switching on the cooling fan. Overload on the transformer will detected by the processor from voltage divider circuit and send the information to alarm so that operator will be alerted.

In this paper digital model for monitoring and control of transformer parameters is developed as per the following steps.

Step 1: Sensors sense the transformer conditions

Step 2: The sensed information is sent to the PIC16F876A microcontroller

Step 3: The processor sends the sensed information to the peripherals to act.

DIGITAL MODEL OF MONITORING CUM CONTROL

The entire Digital Model for condition monitoring of the transformer is divided into three sections and is as shown in the Figure 3.

The three section of the proposed digital model are

- High Voltage Monitoring Circuit
- Temperature Sensing Circuit
- Load Monitoring Circuit

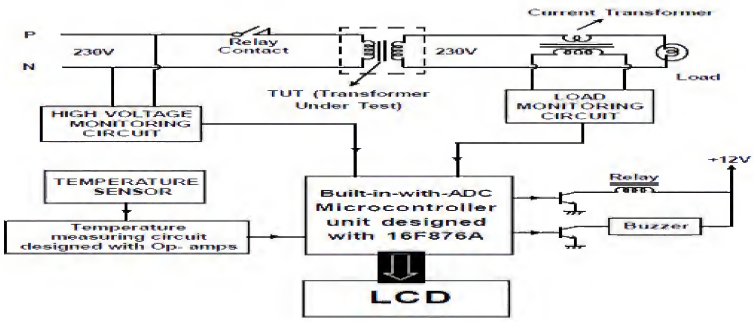

Figure 3: Digital Model of Condition Monitoring

In voltage monitoring circuit, for over voltage parameter monitoring, the input voltage to the transformer primary is fed through autotransformer and the over voltage is checked. In proposed proto type model, single phase transformer with 1:1 ratio is used to operate at 220V AC. As this transformer primary is designed to operate at 220V, it cannot with stand at higher voltage, if the voltage is more than 240V then there is a chance that the transformer primary winding may be damaged due to over voltage. To protect the transformer due to over voltage, the control circuit is programmed to disconnect supply to the transformer primary when input voltage exceeds more than 240V. Supply to the primary is provided through relay contact, so that micro-controller energizes the relay which in turn disconnect the supply to the transformer primary.

For monitoring the line voltage, a step-down transformer of 6V-0-6V center-tapped secondary is used as a line voltage sensor. As transformer primary voltage increases, accordingly secondary voltage also rises, and is rectified, filtered and again with the help of another preset, set value is adjusted to the known required value. The output voltage sensing

circuit is fed to the second channel of internal ADC for converting the analog value in to digital[3]. The controller is programmed to disconnect supply to the transformer primary when the line voltage exceeds to more than 240V. The relay used is common for all the three parameters, whenever any parameter value exceeds to its preset value, immediately relay will be energized, supply to the transformer will be disconnected and at the same time fault condition is displayed through LCD interfaced with controller.

For monitoring the transformer body temperature, SL100 is used as a temperature sensor. The temperature measuring circuit is designed with two op-amps, one op-amp is configured as differential amplifier and the other op-amp is configured as voltage amplifier. The operational amplifier is a highly versatile device which can perform computing & other functions like signal conditioning, active filtering, regulating, process instrumentation etc

For monitoring the secondary load of transformer, current transformer is used with its primary winding connected in series with load carrying the current to be measured and, thus the primary current is dependent upon the load connected to the system and is not determined by the load (burden) connected on the secondary winding of the current transformer[4]. The primary winding consists of very few turns and, therefore, there is no appreciable voltage drop across it. The secondary winding of the current transformer has larger number of turns, the exact number being determined by the turn's ratio. Depending up on the current flowing through primary, proportionate voltage is developed across the secondary.

The output of the CT is rectified, filtered and is fed to the microcontroller where the built in ADC facility in PIC 16F876A controller process the obtained information[5]. This chip is having 5 input channels for the ADC and it can be used for monitoring five parameters. In the present model over voltage and temperature monitoring cum control is effectively achieved.

OBSERVATION FROM HARDWARE MODEL

Figure 4: Hrdware Model **Figure 5: Monitoring of Temperature**

During the abnormal condition (overvoltage), the PIC microcontroller identifies the voltage level and gives the alarm for the transformer protection[6]. In the case of the over temperature, the temperature sensor is activated and the transformer either disconnected or alarm circuit is activated. In extension to the existing hardware model, provision is available for transmitting the observed parameters through GPRS system such that online condition monitoring of the transformer is very much possible.

Table 1: The Observed Parameters is as Shown in the Following

Temperature: 12°c,12.5°c,13°c,13.4°c,14.2°c,33° c, 44 ° c, 54 °c,64 °c, (circuit tripped, alarm activated)
Voltage: 135v, 146v 156v 167v 188v, 196v 213v, 235v, 242v (alarm, circuit tripped)
Current:1.1A, 1.22A, 1.32A, 1.42A, 148A, 1.56A, 1.62A,1.67A,1.83A(alarm , circuit tripped)

Figure 6: Model for Monitoring of over Load

CONCLUSIONS

Digital monitoring cum control of transformer is successfully designed and developed for implementation of single phase transformer. The proposed prototype module effectively monitored and controlled when ever over load condition or over temperatures prevail on the single phase transformer. PIC 16F876A is selected, which avoids external devices like multiple channels ADC and clock signal generator. The developed proto type model is best suited to interface with the GPRS system to transmit the monitored parameters for further better analysis. In addition to the two monitored parameters, another two parameters also can be monitored with the developed model.

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